

# Delta Drinking Water Quality and Treatment Costs

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# Current treatment processes in the Delta

	South Bay Aqueduct							Contra Costa Canal/ Los Vaqueros		North Bay Aqueduct				Southern California				
	Zone 7		ACWD		Santa Clara Water District			Contra Costa Water District		Fairfield Vacaville	Benicia	Vallejo		Metropolitan Water District of Southern California (MWDSC)				
Treatment Process	PP	DV	MS J	TP 2	Penitencia	Rinconada	Santa Teresa	Randall-Bold	Bollman	NBR	Benicia	Fleming Hill	Travis AFB	Robert B. Diemer	Joseph Jensen	Henry J. Mills	Robert A. Skinner	F.E. Weymouth
Water delivered (mgd)	20	36	10	21	42	80	100	40	75	40	10	42	7	520	750	326	630	520
<b>Filtration/ Separation</b>																		
Anthracite/Sand	X	X		X							X			X	X	X	X	X
GAC/Sand					X	X	X	X	X	X		X	X					
Membranes	X		X															
<b>Disinfection</b>																		
Chlorine	X	X	X		X	X	X			X	X	X	X	X	X	X	X	X
Chloramines	X	X	X	X	X	X	X	X	X					X	X	X	X	X
Ozonation				a	b	(b)	b	b	b	a, c		a, b	a	(a)	a	a	(a)	(a)
Ultraviolet																		

a – Pre, b – Intermediate, c – Post – ozonation use, ()- Under construction

SOURCE: CALFED (2005) and MWDSC (<http://www.mwdh2o.com/index.htm> )

# Disinfection Byproducts & Treatment

- DBPs from Bromide and TOC greatest concern.
- Technologies to treat TOC & DOC and bromide to prevent DBP formation
- Alternative disinfection
  - Ozonation (widely used for Delta water)
  - UV irradiation
- Treatment processes for DBP precursor removal
  - Enhanced coagulation (removes TOC)
  - Adsorption (GAC is common)
  - Membrane filtration (MF/UF, NF, and RO)
  - Magnetic ion exchange (removes NOM and bromide)

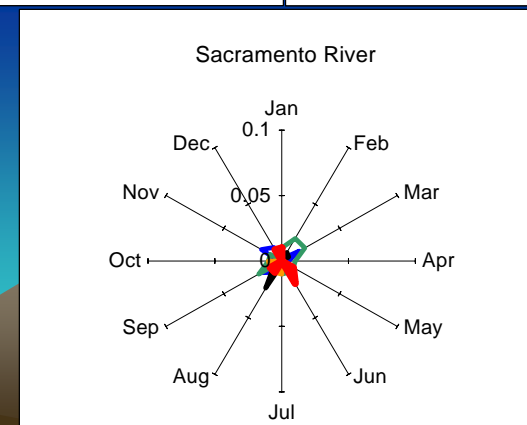
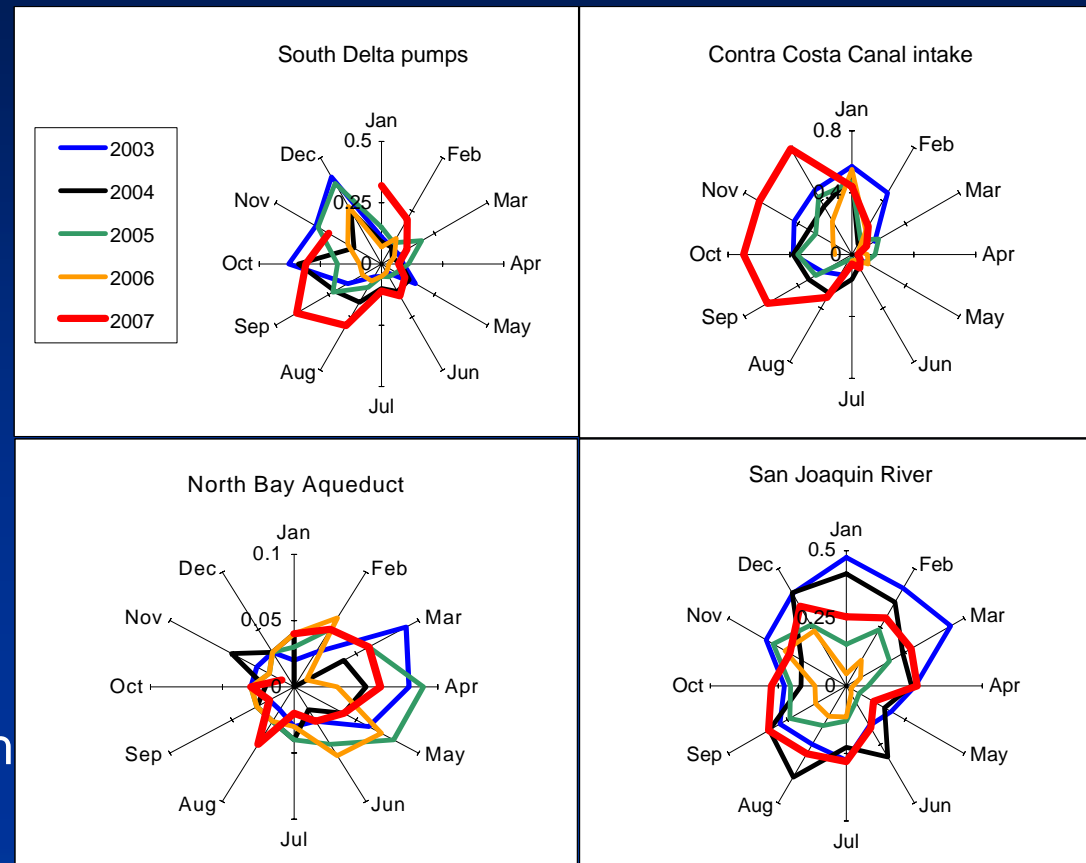
# Treatment Method Limits

- Treatments for Delta water quality conditions to minimize cost within technology limits.
- Results using state and local studies, and may differ slightly due to site-specific conditions or safety factors.
- Ozonation assumed as base treatment technology for disinfection and oxidation.

TOC (mg/l) 3 - 5	Ozone/GAC or Enhanced Coagulation/ Ozone	UV/GAC with/without MIEX/UF
	Ozone	Ozone/MIEX/UF or UV
	0.3 – 0.5 Bromide (mg/l)	

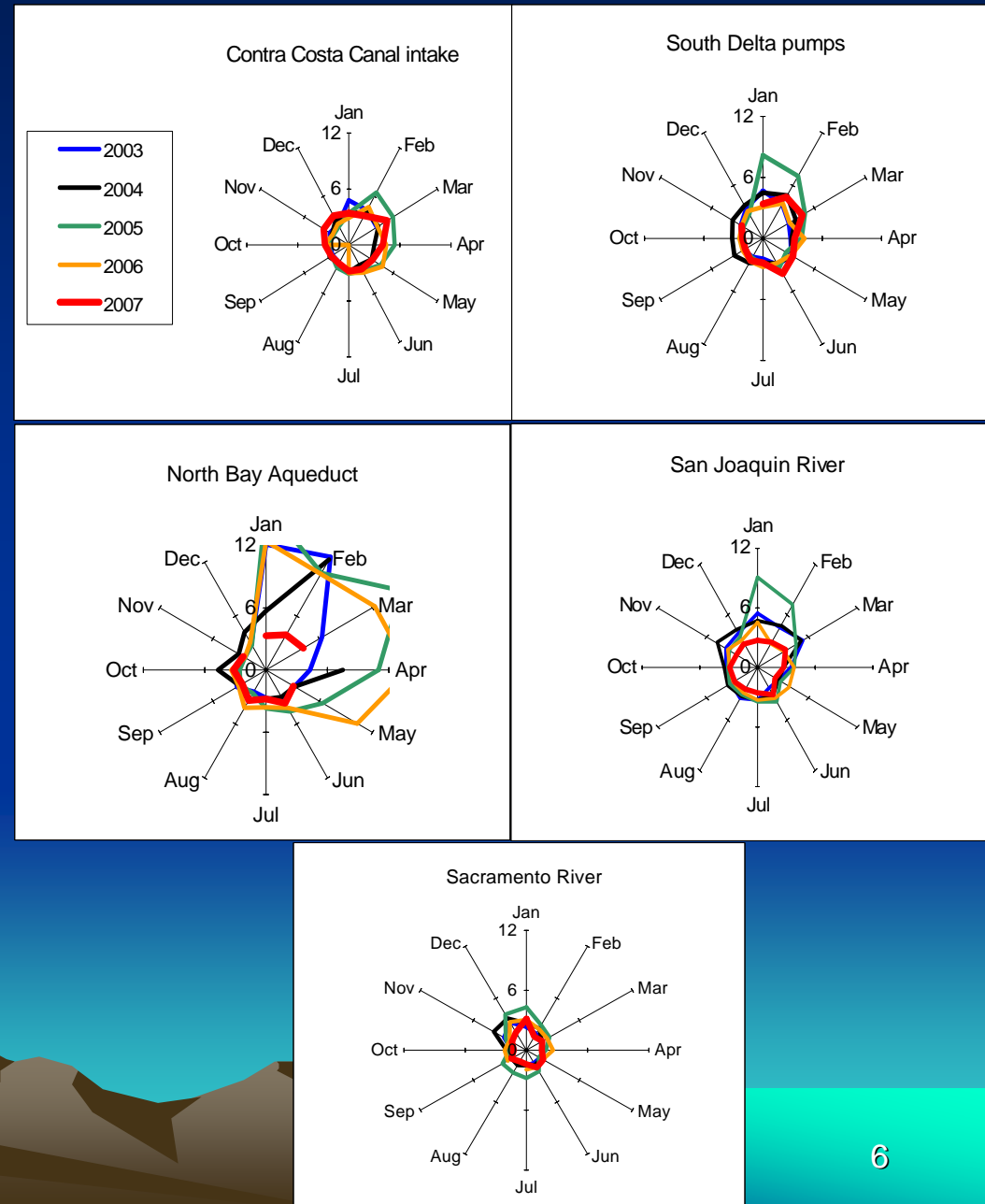
# Recent Bromide Concentrations

- Bromide greatest concern for DBP formation.
- CALFED record of decision (ROD) bromide target concentration of 0.05 mg/l for public health.
- EC, bromide, and chloride show serious salinity problems in the South Delta and San Joaquin River.



# Recent TOC and DOC Concentrations

- Has potential to react with chlorine and ozone to form DBPs.
- High level of organic carbon increases amount of disinfectants required.
- NBA at Barker Slough has a higher TOC/DOC concentration than other selected Delta locations.



# Current and future water quality conditions at Delta intakes

Location	Time	Concentration of constituents (Low, <b>Average</b> , High)				
		Conductance (EC, $\mu$ S/cm)	Bromide (mg/l)	Chloride (mg/l)	TOC (mg/l C)	DOC (mg/l C)
Sacramento River	Current (2003-2007)	73, <b>155</b> , 232	0, <b>0.01</b> , 0.02	2, 6, 10	1.4, <b>2.4</b> , 7.0	1.3, <b>2.0</b> , 4.3
San Joaquin River	Current (2003-2007)	109, <b>636</b> , 1143	0.02, <b>0.25</b> , 0.48	8, <b>71</b> , 160	2.7, <b>4.8</b> , 10.7	2.1, <b>3.7</b> , 9.0
North Bay Aqueduct	Current (2003-2007)	136, <b>299</b> , 572	N.D., <b>0.04</b> , 0.09	6, <b>20</b> , 50	2.7, <b>7.9</b> , 52.5	2.4, <b>5.5</b> , 15.9
South Delta pumps at Banks	Current (2003-2007)	125, <b>355</b> , 671,	0.03, <b>0.15</b> , 0.41	11, <b>52</b> , 130	1.9, <b>3.8</b> , 5.7	2.0, <b>3.2</b> , 8.2
	1 ft SLR	126, <b>455</b> , 1166	0.03, <b>0.16</b> , 0.85	11, <b>80</b> , 259	N.A.	N.A.
	3 ft SLR	126, <b>741</b> , 2120	0.03, <b>0.50</b> , 1.64	11, <b>152</b> , 500	N.A.	N.A.
	W Is. Fail	210, <b>439</b> , 729	0.06, <b>0.25</b> , 0.49	18, <b>76</b> , 149	N.A.	N.A.
Contra Costa Water District	Current (2003-2007)	151, <b>497</b> , 1212	0.03, <b>0.25</b> , 0.79	10, <b>84</b> , 217	2.2, <b>3.5</b> , 6.3	2.1, <b>3.3</b> , 6.5
	1 ft SLR	151, <b>679</b> , 2010	0.03, <b>0.45</b> , 1.55	10, <b>137</b> , 472	N.A.	N.A.
	3 ft SLR	151, <b>1153</b> , 3360	0.03, <b>0.84</b> , 2.67	10, <b>256</b> , 812	N.A.	N.A.
	W Is. Fail	183, <b>607</b> , 1064	0.04, <b>0.39</b> , 0.77	12, <b>118</b> , 234	N.A.	N.A.
Record of Decision (ROD) target concentration		-	0.05	-	3	-

# Treatment Costs for Future Conditions

- Sea level rise and western island failure increases total costs to treat Delta water.
- Most likely treatment processes and costs in bold.
- Some treatments might be impractical. UV or additional treatment technologies might be needed.

Plant /Intake Location	Condition	Bromide (mg/l)	Estimated costs (\$/AF)				
			Enhanced coagulation /Ozone	In combination with GAC	In combination with MF/UF	In combination with MIEX/MF /UF	In combination with NF
Sacramento River (Medium plant)	All	0.01	<b>37 - 62</b>	100 - 343	251 - 363	301 - 463	402 - 525
Sacramento River (Large plant)	All	0.01	<b>35 - 40</b>	74 - 187	193 - 254	243 - 354	329 - 405
CCWD	Current (2003-2007)	0.25	<b>66 - 91</b>	128 - 373	280 - 392	330 - 492	431 - 555
	1 ft SLR	0.45	91 - 127	<b>153 - 409</b>	305 - 428	355 - 528	455 - 591
	3 ft SLR	0.84	147 - 183	209 - 465	<b>360 - 484</b>	<b>410-584</b>	511 - 647
	W is. Fail	0.39	82 - 119	<b>145 - 400</b>	296 - 420	346 - 530	446 - 582
South Bay (South Delta export)	Current (2003-2007)	0.15	<b>53 - 78</b>	115 - 359	266 - 379	316 - 479	417 - 541
	1 ft SLR	0.26	63 - 100	<b>126 - 381</b>	277 - 401	327 - 501	428 - 563
	3 ft SLR	0.50	98 - 134	<b>160 - 416</b>	311 - 435	361 - 535	462 - 598
	W is. Fail	0.25	62 - 98	<b>124 - 380</b>	276 - 399	326 - 499	426 - 562
Southern California (South Delta export)	Current (2003-2007)	0.15	<b>46 - 53</b>	85 - 199	204 - 266	254 - 366	340 - 417
	1 ft SLR	0.26	61 - 78	<b>124-360</b>	275 - 379	325 - 479	426 - 542
	3 ft SLR	0.50	96 - 113	<b>158-394</b>	309 - 414	359 - 514	460 - 576
	W is. Fail	0.25	60 - 77	<b>122-359</b>	274 - 378	324 - 478	425 - 541



# Conclusions

- Contra Costa Canal intake has highest treatment cost increases.
- Treatment cost difference between South Delta and Sacramento River will increase from \$20 - \$60/af to \$100 - \$500/af.
- With 1.5 million af/yr use, treatment cost difference increases from \$30 - \$90 million/yr currently to \$200 - \$1000 million/yr in the future.
- Residual health risks may significantly affect selection and operation of water treatment.

Plant/Intake location	Annualized treatment cost (\$/af)			
	Current (2003 – 2007)	1 ft SLR	3 ft SLR	W Is. Fail
Sacramento River (Medium plant)	37 – 62			
Sacramento River (Large plant)	35 – 40			
CCWD (Contra Costa Canal intake)	66 - 91	153 – 409	410 – 584	145 - 400
South Bay (South Delta pumps)	53 – 78	126 – 381	160 – 416	124 – 380
Southern California (South Delta pumps)	46 – 53	124 – 360	158 – 394	122 - 359